Torres, Francine

From:	Mohdabari@aol.com%inter2 [Mohdabari@aol.com] on behalf of Mohdabari@aol.com
Sent:	Tuesday, February 22, 2005 6:19 PM
To:	Torres, Francine
Subject:	Ferric phosphate petition
Attachments:	ATTACHMENT.TXT; slug control field study.doc

ARTICHOKE RESEARCH ASSOCIATION

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February 23, 2005

Francine Torres
National Organic Program
USDA-AMS-TMP-NOP
1400 Independence Ave., SW
Room 4008-So, Ag Stop 0268
Washington, DC 20250-0200

Dear Ms. Torres:

According to the summary of TAP analyses two reviewers voted against allowing ferric phosphate as molluscicide for organic crop production based on the pretext that other organic alternatives exist. With this letter I am submitting my arguments against this decision. I consider myself an authority on the control of slugs, snails, and various arthropod pests in artichokes with thirty years of experience in this field.

It is true that there are several alternatives to chemical control of slugs and snails available but all the methods I found in the literature are only feasible in the following situations: Home gardens (handpicking, trapping with cardboard, beer trap), Orchards (use of barriers such as copper stripping, taping, and banding to protect trees against mollusks from moving in), and Greenhouse and Nursery plants (trapping, use of various kinds of barrier, and repellent). Some other methods mentioned in the literature such as biological and cultural control either could be used on very small organic farms or they are rather ineffective in dealing with chronically high infestation levels.

The methods mentioned above are particularly ineffective as well as lack economic feasibility when considered for controlling the mollusks in globe artichokes (Cynara scolymus) because of the following reasons:

In California, the artichokes are grown near central coast under cool foggy conditions. The individual field sizes are fairly large ranging from 50 to several hundred acres at any particular site. The organically grown artichokes are gaining popularity and the acreage under this type of farming is growing every year. Currently the estimated acreage under the organic artichokes is 300 acres throughout California with an average field size being 5-10 acres.
Globe artichoke is a perennial crop of fairly large size plants growing to a height of 2 to 4 feet or more and spread to cover an area 3-6 feet in diameter. The crop is evergreen and produces its fruits (artichoke buds) continuously throughout the year. Plant densities ranging from 1000 to 2000 plants per acre result in plant rows of contiguous dense foliage providing permanent refuge for various pests.

The high density planting, cool foggy climate, and crop's perennial growth make the field habitat quite suitable for the prolific growth and high survival of several pests including slugs and snails. Under the conditions described above the mollusk control method alternative to ferric phosphate are either ineffective or they are economically not feasible. The mollusksâ€™ infestations in these fields are well established and they are not due to migration of these critters from areas outside the field. Hence, the banding and taping to bar them has no value. At present the only economically feasible and effective method to control them is through baiting. Our field trials have indicated that the application of ferric phosphate is not only economically feasible but it is highly effective for the control of these pests. With this management practice a grower would be able to avoid crop losses amounting to $250-300/acre/year. I am enclosing a recent field study conducted to compare various field strategies for slug management in artichokes. In this report you will find the magnitude of crop losses resulting from slug damage when no control management is attempted. Similar losses are currently experienced in organically grown artichokes as well where no slug control measures are available.

I strongly urge the NOSB panel to issue the approval of ferric phosphate for molluskså€™ control in various crops.

Sincerely,

Mohammad A. Bari
Entomologist

Enclosure: Field study report: Efficacy of Mesurol Pro, Deadline, slugfest, and Sluggo Against the Garden Slug in artichokes.

GLOBE ARTICHOKE: *Cynara scolymus* (L.)
Gray Garden Slug, *Deroceras reticulatum* (Muller) *(Agriolimax reticulatus)*

Mohammad A. Bari
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Comparative Efficacy of Various Slug Baits Against the Gray Garden Slug, Infesting Globe Artichoke, 2004

In recent years, gray garden slug has increasingly become a serious pest of artichokes. This change is perhaps because of significant deviations from certain agronomic and cultural practices. For example, to avoid root damage at crop's annual cut-back, growers are cutting their artichoke plants at a shallower depth, which often result in a greater survival and carryover of slug populations from one season to the next. Another practice that has more or less similar effect on slug population is the high density planting that prevents cross cultivation of artichoke fields. Sub-surface drip irrigation seems to discourage slugs from foraging on the dry soil surface. Consequently, the slugs seem to take refuge in the fronds of artichoke shoots, which remain moist for most part of the day and fortuitously feeding on the tender developing buds.

Slugs cause two kinds of damage artichoke buds. 1. The bacterium, Erwinia invades the vascular tissue of the leaf petiole and plant roots through the injury resulting from slug-feeding and cause shoot rot. 2. As the artichoke buds begin to form, slugs feed on the tender immature buds by rasping their outer surface. As these buds mature, the injury to the outer bracts develops into brown streaks blemishing the appearance of the affected artichoke bud, consequently lowering its quality and market value. In the case of a severe injury, the outer bracts dry up rendering the bud unmarketable. Often the rasping of the bud surface is deep that creates holes in bracts as the bud matures.

QuickTime™ and a
TIFF (Uncompressed) decompressor
are needed to see this picture.

Fig 1. Slug feeding damage to immature artichoke buds while in fronds.

Fig 2. Primary buds with severe slug feeding damage making them unmarketable.

Several types of bait products are available for the control of slugs in artichokes. Majority of these products contains the molluscicide, metaldehyde, the concentration of which varies from 3.25-6%. These baits may also vary in pellet size, in the type or amount of slug/snail attractant, and other carrier substances that influence the consistency after the field application. These differences may affect the efficacy of various commercially available baits.

Artichoke growers vary in their slug management practices also. A majority of the growers treats their fields immediately after the annual cut-back of the artichoke plants by applying 10-20 pounds of metaldehyde bait per acre. The crop is treated again 2-3 times through October. A few growers treat their crop more often starting immediately after the field cut-back and continuing baiting through fall. Many growers apply the bait manually, especially during crop's bud production phase. In this type of application, the bait is uniformly scattered over the bed top close to the artichoke plants. This is done in an effort to minimize the contamination of artichoke buds with the bait particles.

Field studies conducted in the past have indicated that slug density remained low through July and showed an increasing trend from August through October. By the first week of October, up to 32-fold increase in the density occurred in untreated fields whereas the increase was only10 to 12-fold in the most effective slug management strategy, which consisted of Deadline (4% metaldehyde) bait applied at 3-wk intervals. By the fourth week of October, slugs were noticed to return to the July level. A significant decline also occurred in the untreated fields but the slugs remained at population levels that were 5 to 10-fold higher than the level they were at in July. The crop injury data collected in these studies indicated that bud damage was significant in the untreated plot during the months of August, September, and October. After October, the crop injury was insignificant regardless of the slug management practice adopted.

Objectives

We initiated the following research project for the growing season 2004-05 to evaluate:

1. The short-term and long-term effect of baiting artichoke fields in late winter (at the end of rainy season) on slug density and

2. To evaluate the efficacy of various slug management strategies using different commercial baits with the active ingredient consisting of methiocarb (Mesurol Pro: Gowan company), metaldehyde (Deadline: AMVAC; Slugfest: OrCal), and iron phosphate (Sluggo®: Neudorff North America) against the gray garden slug in artichokes.

Materials and Methods
In February 04, we secured approximately 2.5 acres of a commercial artichoke field at Molera Ranch, Castroville (Sea Mist Farms) with a history of high slug infestation. The area was divided into two equal halves (East and West) each consisting of 14 rows (row and plant spacing: 10 ft X 3.3 ft). On March 11 the western side was treated manually with Deadline Bullets using a rate of 15-lb/acre and the eastern side was left untreated. Two weeks after the bait application, the immediate effect of the bait application on slug density was measured by counting the number of live slugs from 200 randomly selected vegetative shoots each from the treated and untreated areas of the field.

The plants in the study area and in all other fields at this location were cut-back on May 25, 2004 to culminate the 2003-04 cropping season and to initiate the new season. Two days after the cut-back operation the second part of the study (Objective 2) was initiated by making the first bait application from various slug management strategies. The east and west portion of the study area each were divided into four blocks (replications) and seven treatments, each consisting of 2. The various strategies included in the test are listed in Table 1.

Table 1. Treatments and dates of bait application.

Treatments (Strategies)	Dates of bait application	Crop Stage*
T-1. Mesurol Pro 2%	May 27	vegetative
T-2. Mesurol Pro 2%	May 27	vegetative
Deadline® MP 4%	Jul 16	vegetative
Deadline® Bullet 4%	Sep. 10	production
T-3. Deadline® MP 4%	May 27, Jul. 16	vegetative
Deadline® Bullet 4%	Aug. 13, Sep .10, Oct 5	production
T-4. Deadline® Bullet 4%	May 27, Jul. 16	vegetative
	Aug 13, Sep. 10, Oct 5	production
T-5 Slugfest (oat bait) 4%	May 27, Jul. 16	vegetative
Slugfest (oat bait) 4%	Aug. 13, Sep. 10	production
T-6 Sluggo 1%	May 27	vegetative
Deadline® MP 4%	Jul. 1	vegetative
Sluggo 1%	Aug. 13, Sep. 10	production
T-7 Untreated Control (UTC)		vegetative/production

*Mesurol and Deadline MP use in various treatments was confined to the vegetative phase

Baits in each treatment strategy were hand applied on specified dates at the rate of 15-lb per acre. To achieve this rate, scoops were constructed from plastic tubes to accommodate the exact amount of bait needed for the space covered by each plant. Due to considerable differences in pellet shape and size among the various bait products tested in this trial, a different scoop was constructed for each product after calibration. During crop's vegetative phase, the baits were applied as broadcast over the plant bed. Later with the beginning of crop's production phase when buds began developing and became visible, baits were applied by scattering them by mainly targeting the lower portion of the plant canopy to avoid bud contamination.

Observations

Slug density: Slug density was measured regularly at 2-wk interval beginning from June 15 through October 13. This was accomplished by counting the number of live slugs present on 20 randomly selected artichoke shoots per plot (2-3 shoots per plant). These observations generally began 30-60 minutes before sunrise. The data collected in each observation were analyzed statistically after appropriate transformation (Table 2a-c).

Feeding damage: Slug feeding damage (FD) to artichoke buds harvested in August through October was recorded at 1-2 week interval by rating the feeding injury on a scale of 0-2 (FD-0 = no feeding damage, FD-1 = slight to moderate damage, and FD-2 = severe damage making the bud unmarketable, Fig 2). In each plot, all mature primary and secondary buds ready for harvest were examined for the degree of damage and rated accordingly. Generally, the primary buds suffer the most damage, as they are the first to initiate in the fronds of artichoke shoots and are exposed to slugs longer than the secondary buds (buds that are formed on the stalk below the primary buds). Therefore, we used the damage to the primary buds only as the indicator of the relative efficacy of the various slug management strategies. Bud damage data collected at each harvest were pooled by month and also for the entire period from the beginning of bud production through October, by which time the slug densities in all baiting strategies had diminished below the economic level of 2 slugs/shoot.

Results

Objective 1: The short-term and long-term effect of baiting artichoke fields in late winter (at the end of rainy season) on slug density.

Slug densities recorded at 2-wk post-treatment interval after the March 11 application of Deadline Bullets to the west side of the study area indicated only a slight decrease in the slug infestation level as compared to the east side, which remained untreated. In this observation the slug densities in the treated and untreated areas were below the economic threshold level of 2 slugs per shoot (Fig. 3) and consequently the slug feeding damage to the winter and spring production was also negligible.

Slug counts taken after the cut-back indicated that the slug infestation levels in various baiting strategies were generally lower on winter-treated side as compared to the same strategies on the untreated side. However, these differences were not significant. In

UTC, however, slug densities recorded on July 13, Aug 2, and September 29 were significantly lower in the winter-treated side (Table 2a-b).

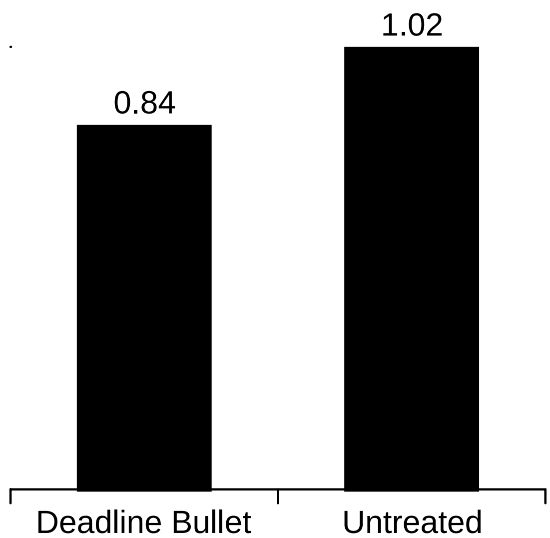

Fig. 3. Mean number of slugs per shoot on March 25 (2-wk post-treatment).

Objective 2: To evaluate the efficacy of various slug management strategies using different commercial baits.

<u>Slug density</u>:
The slug density data recorded in various treatments on different dates on the west and east sides of the study area are presented in Table 2a and Table 2-b respectively. Data presented in Table 2-c represents the means for individual treatments from Tables 2-a and 2-b.

The low population density observed on June 15 in all treatment strategies and UTC (Tables 2a-c) indicate that the cultural practice of cutting the artichoke plants down to ground level plays a major role in the elimination of a significant portion of slug population, thereby limit the carrying over of large slug population into the new cropping season. From these data it is evident that slugs underwent two generations from the time of cut-back through October. The first generation peaked in middle of July with the mean slug density reaching the level of 2.09 slugs per shoot in UTC. For the second generation, the population started building up in the second week of August and reached the peak by September 29 with the mean slug density reaching the level of 11.23 slugs per shoot in UTC (Table2-c).

While the mean slug densities recorded on various dates for the first generation were considerably lower in all baiting strategies than that in UTC, these differences were generally not significant. Strategies involving Mesurol recorded the lowest slug densities in spite of making use of least number of bait applications. Also differences among baiting strategies using metaldehyde and iron phosphate were not significant.

Table 2-a. Slug density (mean number of slugs per shoot*) recorded on specified dates in various baiting strategies from the study area (west side) receiving the winter treatment of slug bait.

Treatment Number	15-Jun	1-Jul	13-Jul	2-Aug	19-Aug	1-Sep	15-Sep	29-Sep	13-Oct	Seasonal Mean
T-1	0.05 a	0.03 a	0.22 a	0.07 a	1.15 a	2.35 a	1.25 a	1.25 ab	0.80 a	0.80
T-2	0.03 a	0.19 a	0.30 a	0.02 a	1.65 a	2.25 a	1.30 a	1.45 ab	0.10 a	0.81
T-3	0.06 a	0.39 a	0.72 a	0.05 a	1.08 a	1.80 a	1.60 a	2.85 b	0.30 a	0.98
T-4	0.08 a	0.47 a	1.05 a	0.07 a	0.63 a	1.75 a	2.20 a	3.30 b	0.20 a	1.08
T-5	0.23 a	0.53 a	1.42 a	0.13 a	1.85 a	2.13 a	1.25 a	0.30 a	0.10 a	0.88
T-6	0.08 a	0.51 a	0.25 a	0.12 a	0.90 a	1.30 a	4.20 b	4.10 b	2.30 a	1.53
T-7	0.10 a	0.81 a	1.47 a	0.32 a	5.08 b	7.43b	9.78 c	7.60 c	5.60 b	4.24

Means under specific dates followed by the same letter are not significantly different (LSD TEST; *P*>0.05).

Table 2-b. Slug density (mean number of slugs per shoot*) recorded on specified dates in various baiting strategies from the study area that was not treated in winter (east).

Treatment Number	15-Jun	1-Jul	13-Jul	2-Aug	19-Aug	1-Sep	15-Sep	29-Sep	13-Oct	Seasonal Mean
T-1	0.00 a	0.12 a	0.21 a	0.03 a	1.15 a	1.93 a	1.25 a	1.65 a	0.30 a	0.74
T-2	0.05 a	0.25 a	0.27 a	0.05 a	1.18 a	2.13 a	2.05 a	1.80 a	0.30 a	0.90
T-3	0.00 a	0.69 a	1.77 b	0.23 a	1.43 a	1.58 a	3.05 a	4.30 b	0.50 a	1.50
T-4	0.00 a	0.81 a	1.30 b	0.47 a	1.53 a	2.98 a	2.80 a	2.75 a	0.30 a	1.44
T-5	0.00 a	0.72 a	2.52 b	0.65 ab	1.23 a	1.65 a	1.95 a	1.60 a	0.00 a	1.15
T-6	0.00 a	0.64 a	0.77 ab	0.83 b	1.35 a	1.18 a	2.50 a	6.50 b	1.10 a	1.65
T-7	0.10 a	0.92 a	2.71 b	1.15 b	6.05 b	5.78 b	8.70 b	14.85 c	2.60 b	4.76

*Means under specific dates followed by the same letter are not significantly different (LSD TEST; *P*>0.05).

Table 2-c. Slug density (mean number of slugs per shoot*) recorded on specified dates in various baiting strategies after pooling the data presented in Tables 2a and 2b.

Treatment Number	15-Jun	1-Jul	13-Jul	2-Aug	19-Aug	1-Sep	15-Sep	29-Sep	13-Oct	Seasonal Mean
T-1	0.03 a	0.08 a	0.22 a	0.05 a	1.15 a	2.14 a	1.25 a	1.45 a	0.55 a	0.77
T-2	0.04 a	0.22 a	0.29 a	0.04 a	1.41 a	2.19 a	1.68 a	1.63 a	0.20 a	0.85
T-3	0.03 a	0.54 a	1.25 ab	0.14 ab	1.25 a	1.69 a	2.33 b	3.58 ab	0.40 a	1.24
T-4	0.04 a	0.64 a	1.18 ab	0.27 ab	1.08 a	2.36 a	2.50 b	3.03 ab	0.25 a	1.26
T-5	0.12 a	0.63 a	1.97 b	0.39 b	1.54 a	1.89 a	1.60 a	0.95 a	0.05 a	1.01
T-6	0.04 a	0.58 a	0.51 a	0.48 bc	1.13 a	1.24 a	3.35 c	5.30 c	1.70 b	1.59
T-7	0.10 a	0.87 a	2.09 b	0.74 c	5.56 b	6.60 a	9.24 d	11.23 d	4.10 c	4.50

*Means under specific dates followed by the same letter are not significantly different (LSD TEST; $P>0.05$).

The second generation of the slug started sometimes between Aug. 2 and Aug. 19 and the population reached its peak on September 29 and diminished greatly in the next two weeks. Densities recorded on various dates during this period indicated all baiting strategies to be significantly effective against the second-generation slugs as compared to UTC. Among the baiting strategies from T-1 through T-6, higher mean slug density was recorded in September/October observations in T-6 in which Sluggo bait was used in 3 out of 4 applications.

Feeding damage:
Bud production and harvest commenced in the third week of August. Thenceforth, mature buds were harvested at approximately weekly interval.

Primary buds suffered the major slug-feeding damage as compared to the secondary buds. Therefore, for evaluating the comparative efficacy of various treatment strategies only the damage to the primary buds produced from August through October is considered in this report. The data collected from August through October and from the east and west sides of the study area in various strategies were pooled by month. Ultimately, seasonal means for slug feeding damage on the scale of FD-0 to FD-2 for individual strategies were arrived at. These data are presented in Table 3.

In general, the proportion primary buds culled due to severe slug feeding (FD-2) was significantly low throughout the study period in each baiting strategy as compared to UTC. Likewise, the proportion of undamaged buds (FD-0) was significantly high in all baiting strategies as compared to UTC.

Continued on Page 9…..

Table 3. Mean Slug feeding damage (FD) rating for the primary artichoke buds harvested on various dates from August through October[α].

Treatment No.	Treatment/Strategies	Mean percent of buds under each slug feeding damage rating											
		August			September			October			Seasonal Mean		
		FD-0	FD-1	FD-2	FD-0	FD-1	FD-2	FD-0	FD-1	FD-2	FD-0	FD-1	FD-2
T-1	Mesurol	64.0	36.0	0.0	25.6	62.4	12.1	84.4	15.6	0.0	58.0	38.0	4.0
T-2	Mesurol/Deadline	95.0	5.3	0.0	34.8	60.4	4.8	54.7	45.3	0.0	61.5	37.0	1.6
T-3	Deadline MP/Bullet	84.0	11.0	5.3	27.5	63.7	9.0	35.5	60.8	3.7	49.0	45.2	6.0
T-4	Deadline Bullet	48.0	38.0	14.0	27.0	64.6	8.4	63.8	33.2	3.0	46.3	45.3	8.5
T-5	Slugfest	85.0	10.0	5.0	43.1	55.9	1.0	64.8	35.2	0.0	64.3	33.7	2.0
T-6	Deadline MP/Sluggo	61.0	39.0	0.0	24.3	60.5	15.3	51.4	47.5	1.1	45.6	49.0	5.5
T-7	Untreated Control	0.0	21.0	79.0	2.3	37.4	60.4	12.2	40.1	47.7	4.8	32.8	62.4

[α]Bud damage resulting from slug feeding was rated on the scale of 0 to 2 (FD-0 = free from slug feeding damage, FD-1 = slight to moderate damage affecting the bud quality, and FD – 2 = severe damage making buds unmarketable, Fig 2).

In general, buds maturing in September suffered the most slug-feeding damage. These buds in their early developmental stage were the targets of the second-generation slugs, which began to surge in the third week of August reaching the peak density by the fourth week of September.

Baiting strategy consisting of one application of Mesurol Pro at cut-back followed by two applications of Deadline (Date of applications: July 16 and September 10) resulted in the best control of slug-feeding damage to the primary buds as only 1.6% of the buds produced from August through October were rendered unmarketable. For the September production the bud damage remained at moderately low level of 4.8%. With the solo application of Mesurol Pro in T-1, 12.1% of the buds produced in September were culled indicating that this single bait application was not effective enough to protect buds against the heaving slug population in August and September. Nonetheless, the seasonal mean for the culled artichokes still remained at moderately low level of 4% due to slight damage (0% culls) recorded in August and October.

Among strategies using metaldehyde bait in all applications (T-3 through T-5), Slugfest recorded the least feeding damage to the primary buds in September as only 1% of the buds were rendered unmarketable. Further, in this strategy, highest percentage of buds produced in this month was free of any feeding damage (FD-0). Likewise, only 0% of the buds were unmarketable in October. According to the seasonal means, only 2% of the total production from August through October was culled.

The strategy consisting of the use Deadline MP in the vegetative phase and Deadline Bullets in the production Phase (T-3) was significantly more effective for protecting the August production than the strategy in which Deadline Bullets were used in all applications. The differences between these two strategies for the September and October production were not significant.

The strategy using 3 applications of Sluggo and one application of Deadline MP (T-6) resulted in no culls of primary buds due slug feeding in August. However, the September production suffered the most damage in this strategy, as 15.3% of the buds were unmarketable. In October, the damage diminished to 1.1%, which was lower than the strategies using Deadline in all applications. Consequently, the seasonal mean for Sluggo turn out to be lower than the strategies using Deadline.

Conclusion

Significance of winter application of slug bait

We did not see any short-term benefit from the winter application of slug bait in artichokes. The damage to artichoke buds results when slugs take shelter in the fronds of artichoke shoots from warm and dry conditions, which usually prevail in summer and early fall. Since such conditions do not exist during winter, slugs need not go deep into the fronds and inflict damage to the buds developing amongst the frond leaves. Rather they roam freely on the ground for mating or among the foliage where there is ample food available. For this reason the slug count taken at this time of the year from the shoots is generally very low and the feeding damage to artichoke buds is minor. On the other hand, the prevailing wet conditions during winter cause a quick disintegration of the bait pellets as they swell and crumble away in a very short period of time after application impairing any plausible long-term benefit from such application.

The annual cut-back operation at the end of the cropping season seems to be the single most important factor in eliminating a great portion of the slugs overshadowing any conceivable benefit obtained from the winter application. The validity of this fact is apparent from the very low slug counts in all slug management strategies and in UTC plots whether treated or not treated with the metaldehyde bait in winter.

Efficacy of Mesurol Pro (Methiocarb)

The results of this study indicate that Mesurol was highly effective against the gray garden slug in artichokes. With only one application of this bait at cut-back it was possible to maintained the slug density at low levels throughout the study period. Feeding damage to the primary buds was, however, momentarily high during September when the slugs in the second generation peaked in all treatments. The bud damage, however, was significantly reduced when Mesurol application at cut-back was followed with two applications of Deadline bait from July through September. The high efficacy of Mesurol observed in this study could be attributed to the long persistence of methiocarb in the Mesurol pellets, which held their consistency for much longer period than other baits used in the study. Currently Mesurol is not registered on any food crop in California and its registration on artichokes in near future is unlikely.

Efficacy of Slugfest (Metaldehyde)

Among the various formulations of metaldehyde, the performance of the new "unpelletized" Slugfest bait is intriguing as it outperformed all other registered baits. The slug density in the strategy using this bait remained consistently below the economic threshold of 2 slugs/shoot in all observations. Consequently, slug-feeding damage to artichoke buds also was the least in this treatment as compared to other baiting strategies. By the same token, the proportion of damage-free buds also was the highest in this strategy. This bait consists of boiled, rolled- oats treated with metaldehyde. The much smaller and variable size of the bait particles produced far more feeding point sources (5-6 X) than any other currently available bait. Also, since the bait particles in their crudest form are flat, they tend to stick to artichoke leaves better than the round pellets of Deadline and Sluggo baits, which have the tendency to roll off the foliage soon after their application and fall to the ground. Consequently, slugs roaming over the plant canopy during nights have greater chances of coming in contact with this Slugfest bait as compared to Deadline or Sluggo baits under similar conditions.

In Strategies T3 and T-4 using the Deadline baits, one extra application was made on October 5, skipping this late application in other strategies mainly as an after thought to find out how long Slugfest would proffer slug density and consequently bud damage. The slug count taken on October 13, and the feeding-damage data recorded in October indicated that Slugfest remained more effective through this period in both aspects as compared to all other strategies.

In this study, all baits were hand-applied due to the small size of the experimental area and smaller plot sizes. The feasibility of mechanical application of Slugfest in achieving desirable coverage of the ground and the plant canopy needs to be addressed before recommencing any commercial use.

Efficacy of Deadline MP and Deadline Bullet (Metaldehyde)

It is a standard practice to use 2 applications of Deadline MP during crop's vegetative phase switching to Deadline Bullets with the beginning of bud production making 2-3 applications from August through October. This switch is necessary to avoid any contamination of artichoke buds with the blue pellets of Deadline MP. In the presence of moisture, these pellets have the tendency to leak their stain and when lodged among the bracts of developing bud, the tissues of the buds coming in contact with bait particles are stained attracting undue attention and making the bud look suspicious of "contamination" particularly in the presence of a pellet. In the past, chemical analysis of such buds by CDFA inspectors revealed the presence of unwarranted levels of metaldehyde and the consequence of this finding was unpleasant.

In this study, the slug density data suggest that this standard strategy was not any different in efficacy from the strategy using Deadline bullets in all applications from cut-back through October. However, bud damage data revealed that significantly larger portion of the buds produced in August was culled in strategy using Deadline Bullets during the vegetative phase. Later in the season (September-October) when Deadline Bullets were used in both strategies these differences were not significant. This trend suggests that Deadline MP is more effective than Deadline Bullets perhaps because its pellets are harder and do not crumble and deteriorate as quickly as those of Deadline Bullets.

Efficacy of Sluggo (Iron phosphate)

In this study when the application of Sluggo at cut-back was followed by one application of Deadline MP in the vegetative phase switching back to Sluggo during the production phase (2 applications), slug densities remained low in all observations through September 1, not differing significantly from the strategies using Deadline in all applications. However, from September 15 through October 13, slug densities recorded in this strategy were significantly higher as compared to all other baiting strategies indicating the lower efficacy of Sluggo when the slug density is at its peak. This fact is also apparent from the bud damage data, according to which 15.3% of the buds produced in September were culled, the highest figure among all baiting strategies. But when the seasonal means were considered, the overall proportion of culled artichokes in this strategy was lower than the means for strategies using Deadline in all applications. This could be attributed to the lower bud damage recorded early on in August most probably resulting from the application of Deadline MP on July 1 that was two weeks earlier than the second application date for the other strategies. This application seems to be more timely as it synchronized well with the beginning phase of slug's second generation damping down its surging population through July, thus, effectively protecting the artichoke buds harvested in August. These data point to the fact that for effective slug management, time of baiting is as important as using the most effective bait. Nonetheless, the results of this study suggest that Sluggo can be effectively used in situations where there is a concern of contamination of artichoke buds with metaldehyde. Iron phosphate, the active ingredient in Sluggo is a naturally occurring inorganic chemical, which is exempt from tolerance.